Data Quality Assurance Algorithm

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Key FAA Systems that Benefit from Improved NEXRAD Algorithms

Integrated Terminal Weather System

Medium Intensity Airport Weather System

NEXRAD Algorithms

AP Edited Comprefl

High Resolution VIL

Data Quality Assurance

Enhanced Echo Tops

MIGFA

Weather And Radar Processor

Corridor Integrated Weather System

Why a Data Quality Assurance Algorithm?

- NEXRAD reflectivity data susceptible to
  - Artifacts (bull's-eyes, sun strobes, AGC malfunctions)
  - Clutter (AP- anomalous propagation)

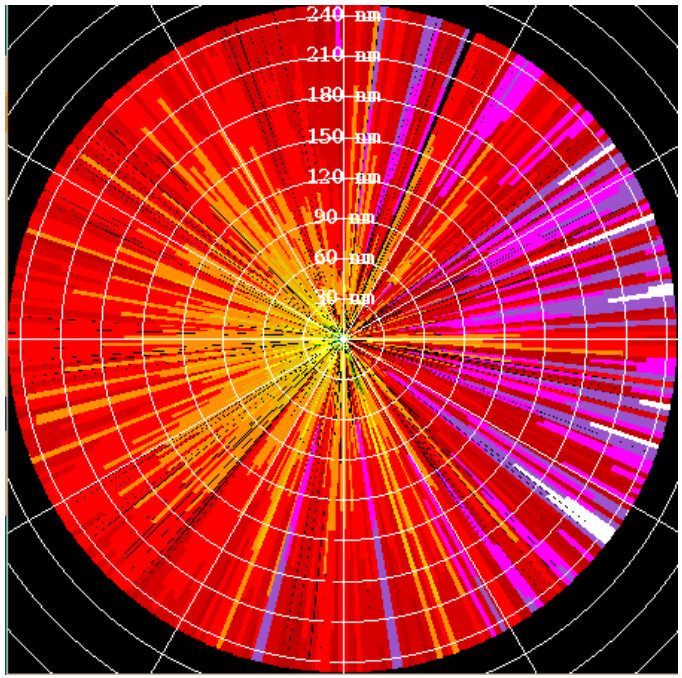
- Operational effectiveness of reflectivity products compromised by contaminants
  - Especially as used by non-meteorologist ATC personnel

- FAA needs maximum removal of contaminants from reflectivity products to achieve goals
  - Increased safety
  - Reduced convective weather delays

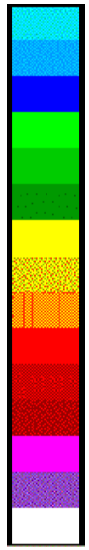
- Solution: An algorithm that removes contaminants through both artifact detection (AD) and AP detection

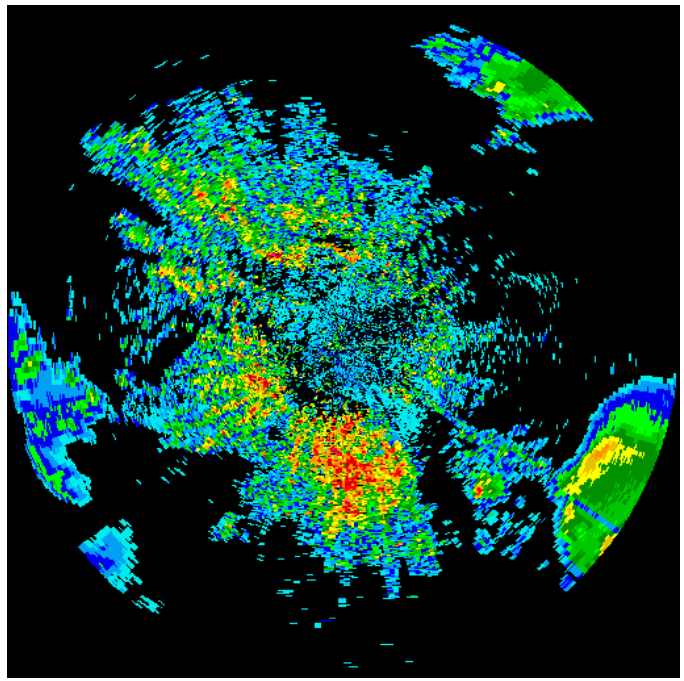
Data Quality Assurance Algorithm

AD



920 km





AP

Base Data →

Remove Constant Power Function Artifacts along radials

Remove AP using Enhanced AP Editing Algorithm

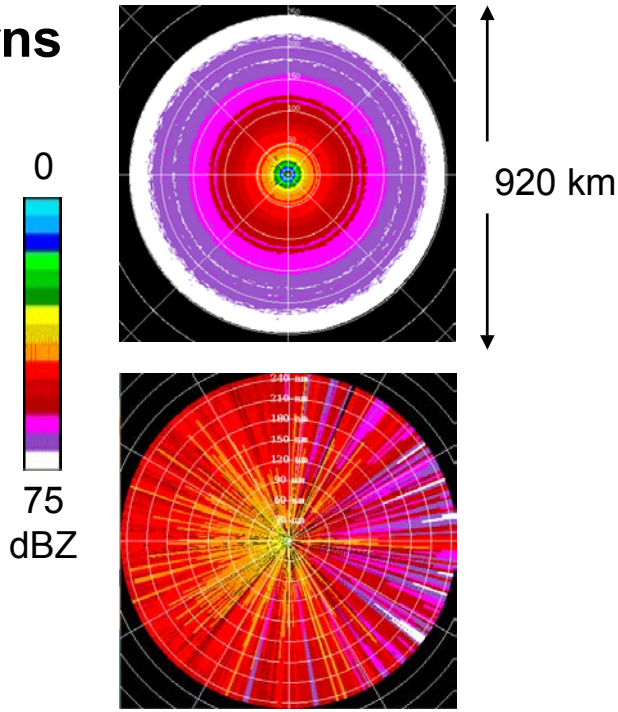
→ High Resolution VIL

⇢ Composite Reflectivity

⇢ Future Products

WSR-88D Artifacts

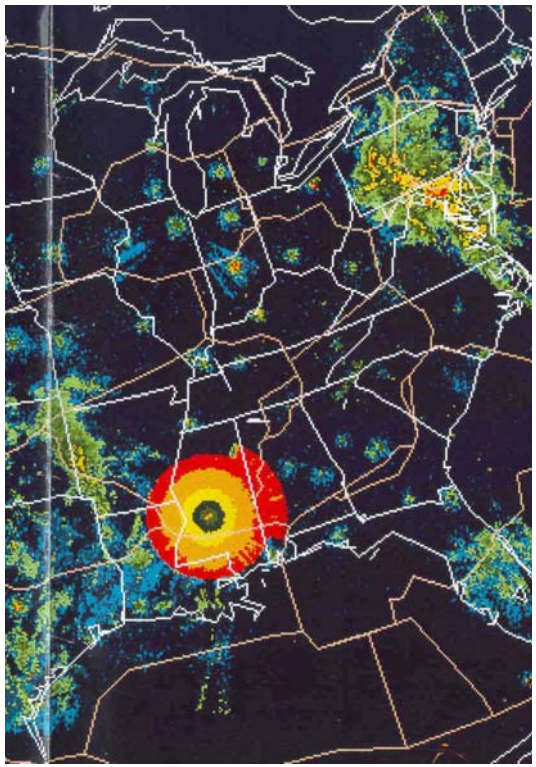
- **Artifacts not limited to "bull's-eye" patterns**
  - **Wedges/spikes/strobes**
  - **Other circular patterns (starbursts)**



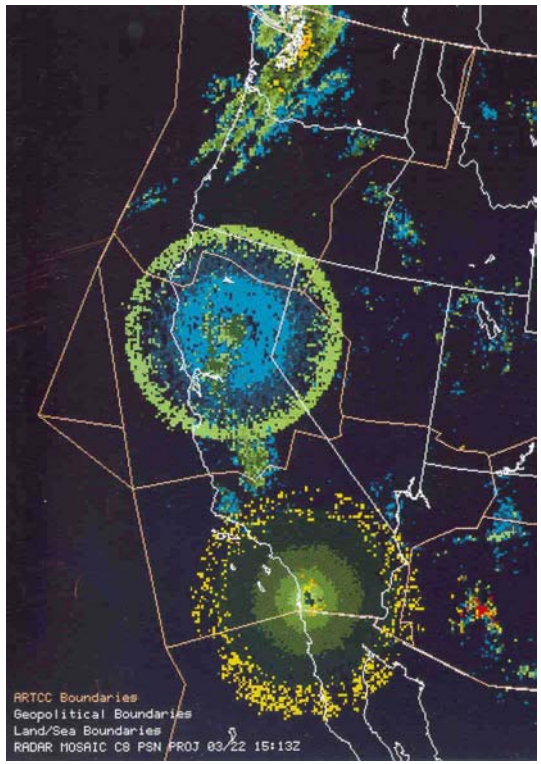
- **Typical sources**
  - **WSR-88D equipment failure**
    - **Loss of AGC attenuation**
    - **Loss of AGC control**
    - **Any other type of receiver failure**
  - **Interference**
    - **FAA and DOD radars**
    - **Aircraft**
    - **Ground based, wireless, cable TV, and other transmitter transmissions**
    - **Solar**

- **Many characterized by a radial constant power function signature**

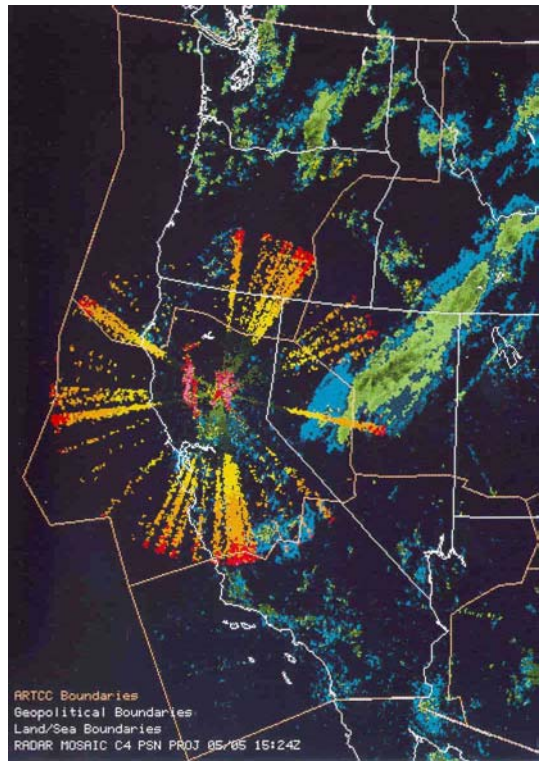
More Artifact Examples



March 21, 2000
1450 UTC
Jackson, MS



March 22, 2000
1513 UTC
San Diego, CA
Beale, CA



May 5, 2000
1524 UTC
Beale, CA

DQA Algorithm Flow – AD Removal

Radials In

Artifacts Detection Logic

- Reference constant power functions created for precip and clear air modes
- Radials segmented into twenty 20 km sections from 60-460 km range
- Segments' modal dBZ level noted
- Exclude radials with weather gaps, no power function, etc.
- Correlate segmented radial to reference constant power function sets
- Clear reflectivity out of radials with identified artifacts

Pass Elevation

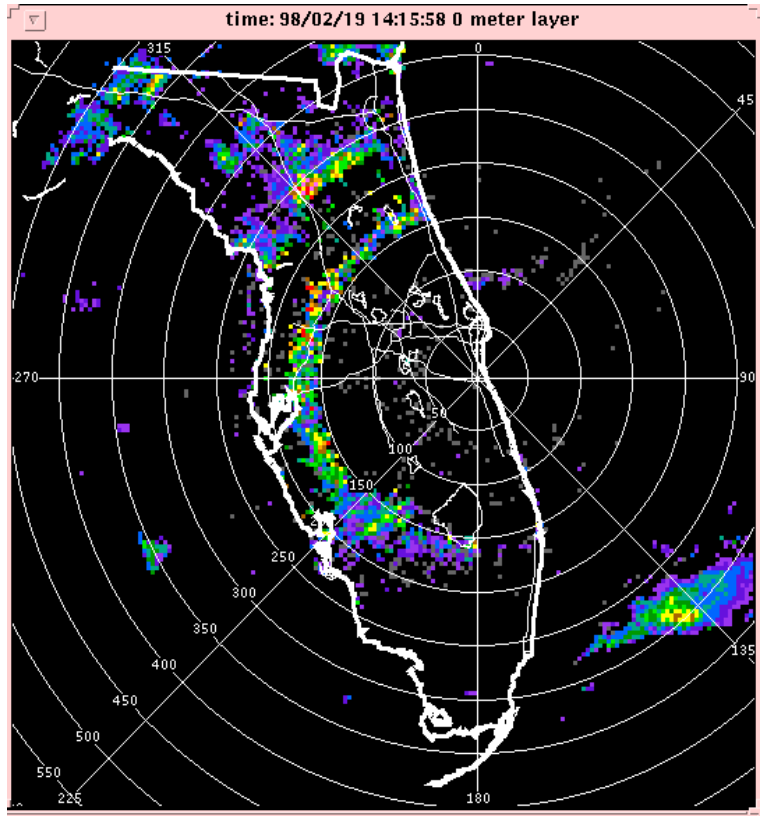
To AP Edit

Source: Logic based on Unisys' WARP artifact detection design document.

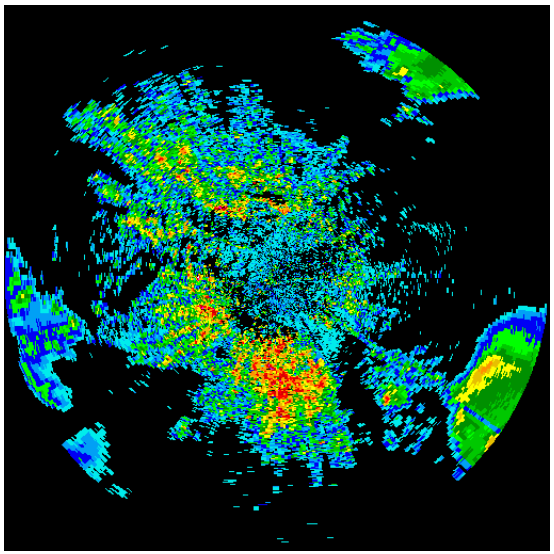
MIT/LL modified for application to all tilts in volume and added exclusion checks.

Ground Clutter
a/k/a Anomalous Propagation (AP)

- NWS meteorologists use clutter filters to remove ground clutter that is “always” present near the radar
- When a temperature inversion causes air at surface to be colder than air aloft, beams are bent toward the ground and AP clutter is encountered unexpectedly
  - Night time/early morning in clear weather
  - After a thunderstorm passes near a radar site
- NWS generally does not use clutter filters to get rid of AP



More AP Examples

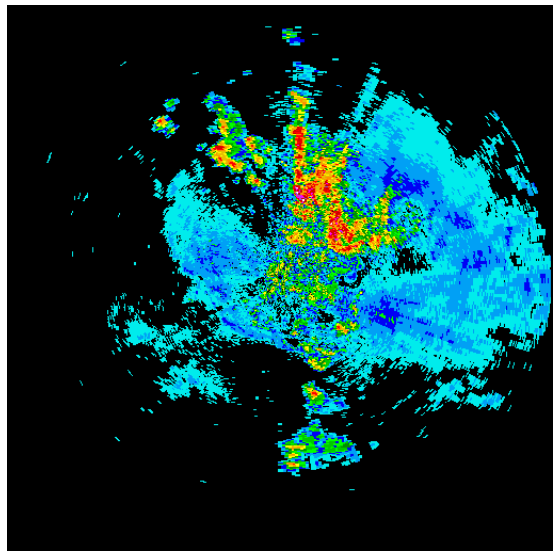


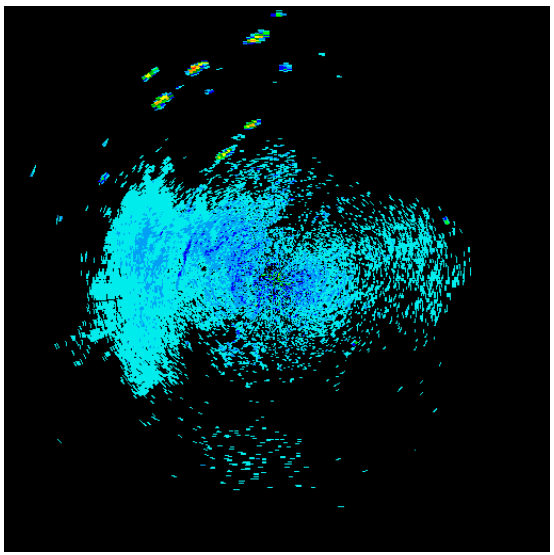
Amarillo
052594
0322 UTC

Strong AP with storms at outer bounds

Fort Worth
100197
1538 UTC

AP embedded with cells to north



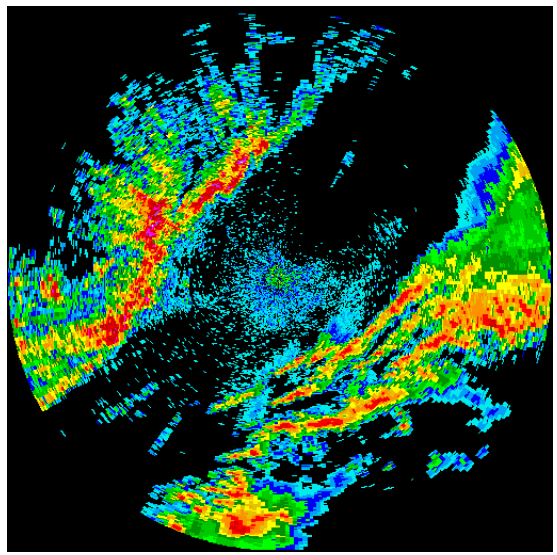


Memphis
082296
1712 UTC

AP with distant scattered small cells

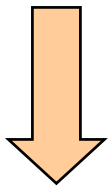
Memphis
042096
1259 UTC

AP to north and west post squall line passage



DQA Algorithm Flow – AP Removal

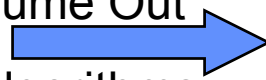
Receive Elevation From AD Edit



AP Edit

- Find gates of AP in radial (small Doppler values + non-weak dBZ)
- Radially expand AP to neighboring gates (1D – Clutter Bloom)
- Further expand AP within a target window of neighboring radials and gates (2D – order statistics Scatter Filter)
- Clear gates found with AP for all radials for all tilts

Volume Out to Algorithms



Enhanced DQA AP Edit vs. Build 1.2 AP Edit

- **Goal**
  - Both maximize AP removal with minimal impact on "weather"
- **Versions**
  - Enhanced AP Edit is original LL AP Edit logic
  - ORPG Build 1.2 is sibling of above (from pre-ORPG) now with modified adaptation parameters
- **Method**
  - Both use removal by region
    - Different reflectivity and Doppler adaptation parameter values
  - removal by extension
    - 1D radial "blooming" similar
    - 2D extension significantly differ
- **Limitation**
  - Both require all 3 radar moments
  - Potential future DQA upgrade to include REC input and/or Princeton U. dBZ texture logic to mitigate

Method

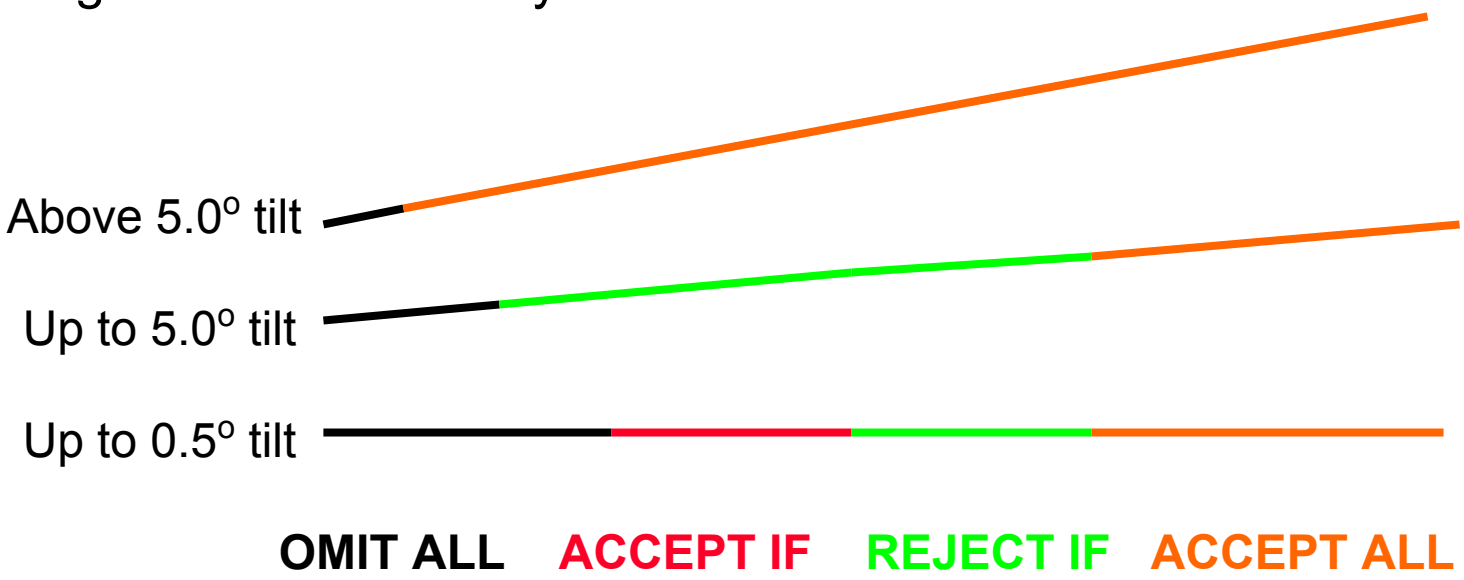
- **Removal by region**
  - **low dBZ in any region prioritized over AP rules**
  - **OMIT ALL - all gates in region are AP**
  - **ACCEPT IF - all gates in region are AP unless proven "weather"**
  - **REJECT IF - all gates in region are "weather" unless proven AP**
  - **ACCEPT ALL - all gates in region are "weather"**
- **Removal by extension**
  - **clutter bloom (1D neighbor extension)**
  - **order statistics filtering (2D neighborhood window extension)**

    LL version uses a scatter filter

    ORPG Build 1.2 uses a median filter with adaptation parameters set to simulate a pseudo-scatter filter result
- **Critical Difference**
  - **The LL scatter filter technique is superior to the ORPG Build 1.2 pseudo-scatter filter method for AP removal and not over smoothing the data**

Regions along Radial for AP Editing

Contiguous range gates along a radial are grouped into regions as a function of elevation angle (tilt), distance from radar, and altitude caps. With processing performed on individual radials, the regions along a radial essentially are as follows:



AP Edit Version Flow Summary

DQA AP EDIT

Removal by Region

Omit All – Accept If: Assumes AP

Reject If – Accept All: Assumes Wx

→ Clutter Bloom

Removal by Extension

Order Statistic Filters –

Scatter Filter Used

Median Filter Not Used

ORPG BUILD 1.2

Removal by Region

Omit All – Accept If: Assumes AP

Reject If – Accept All: Assumes Wx

→ Clutter Bloom

Clutter Bloom logic similar

Doppler and reflectivity adaptation parameters differ

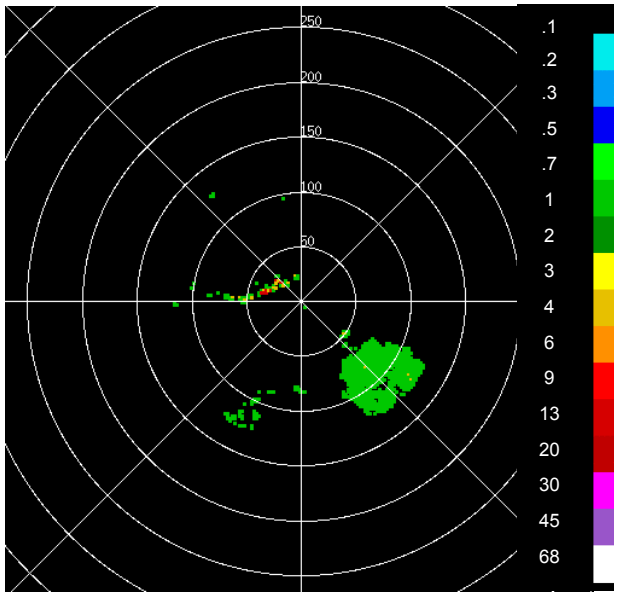
Removal by Extension

Order Statistic Filters –

Scatter Filter Not Available

Median Filter Used as Pseudo-scatter filter

DQA benefits HRVIL product – Sun strobe



Current VIL product

230 km range

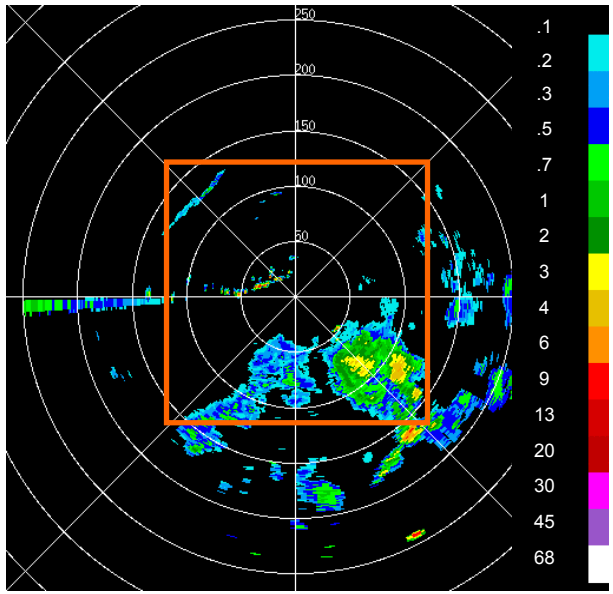
18 dBZ min. threshold

4 x 4 km resolution

Cartesian

16 data levels

continues in Build 2



Build 2 HighRes VIL product

460 km range

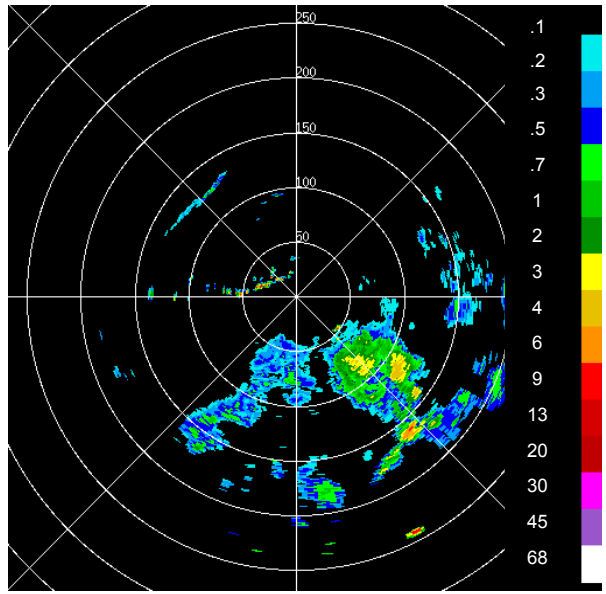
no dBZ threshold

1 degree x 1 km resolution

Polar

253 data levels

release September 30, 2002



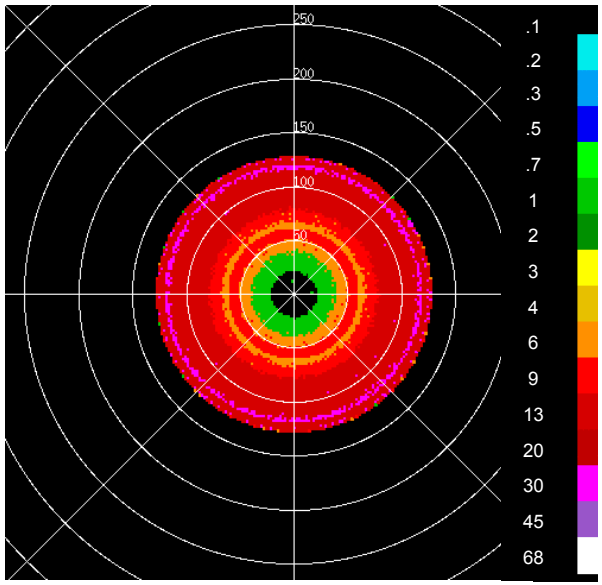
Future Build 3 HighRes VIL product

DQA: AD and AP Edited data input (notice strobe removal)

other specs as HighRes VIL Build 2

release March 31, 2003

DQA benefits HRVIL product – Bull`s-eye



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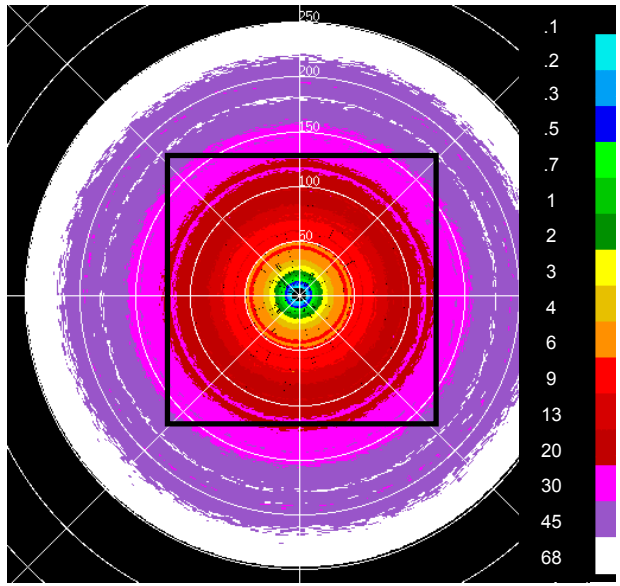

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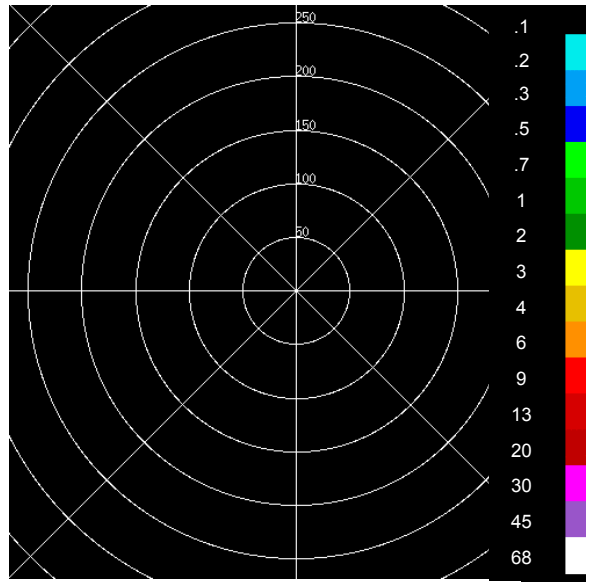

Future Build 3 HighRes VIL product

DQA: AD and AP Edited data input (notice bull's-eye removal)

other specs as HighRes VIL Build 2

release March 31, 2003

DQA Algorithm and ORPG Builds

- Build 3 version currently in testing prior to hand-off to the ROC this July
- High Resolution VIL algorithm retooled to use DQA input for Build 3 (also soon in testing)
- March 2003 begins operational release cycle
- DQA output will be available to any NEXRAD algorithm
- Possible future DQA-edited comprefl product(s) to supercede current AP-edited comprefl products